Quantum Institute Workshop
Quantum Institute Briefing Center; December 9–10, 2002

Decoherence from an Unstable Environment

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An Integrable Model for a Chaotic Environment

Our long-term goal is to understand how chaotic environments produce decoherence in quantum systems. The first stage is to produce and study a model which

- is exponentially sensitive to disturbances
- can be solved exactly

We examine an *inverted harmonic oscillator* environment, coupled to a single SHO system.

$$H = \frac{p^2}{2m_0} + \frac{m_0\Omega^2}{2}x^2 + \frac{q^2}{2m_1} - \frac{m_1\Lambda^2}{2}y^2 + \alpha\sqrt{m_0 m_1}xy \qquad (1)$$

$$\frac{\partial}{\partial t}\hat{\rho} = \frac{1}{i\hbar}\left(\frac{m\omega^2_{\text{eff}}}{2}[\hat{x}^2,\hat{\rho}] + \frac{1}{2m}[\hat{p}^2,\hat{\rho}] + \frac{\gamma_{\text{eff}}}{2}[\hat{x},\{\hat{p},\hat{\rho}\}] - F(t)[\hat{x},\hat{\rho}]\right) \qquad (2)$$
$$-f_1(t)[\hat{x},[\hat{x},\hat{\rho}]] + f_2(t)[\hat{x},[\hat{p},\hat{\rho}]]$$

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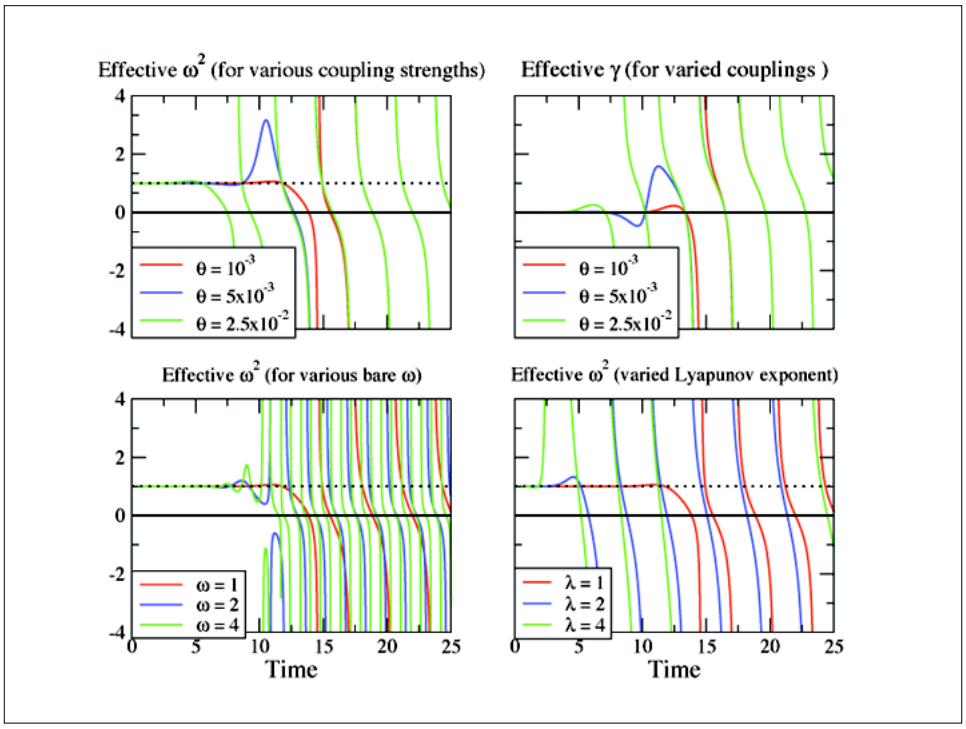

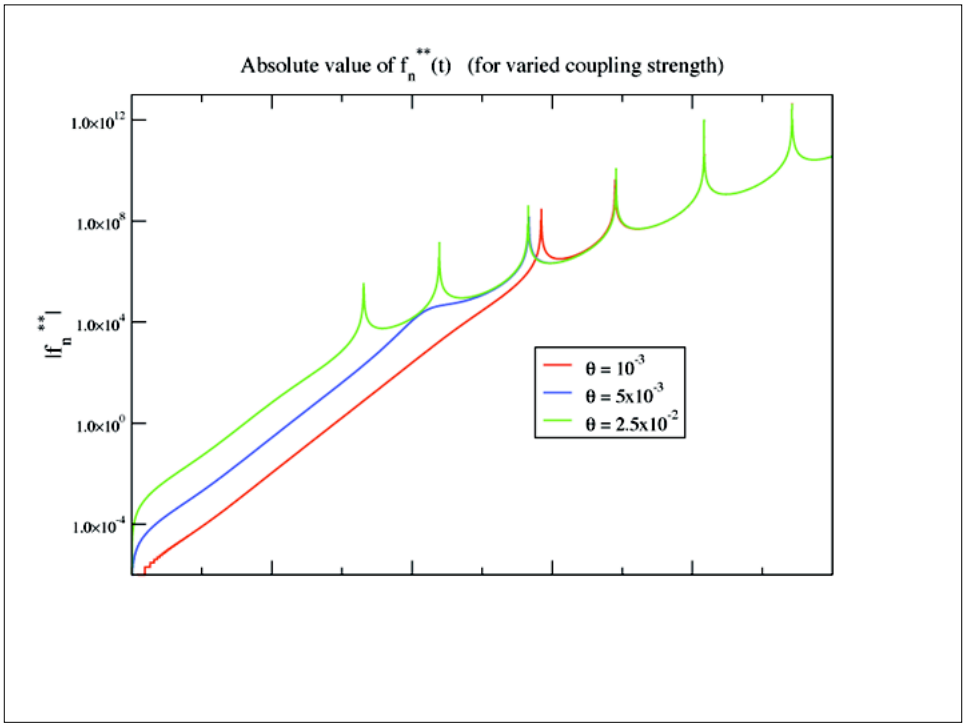

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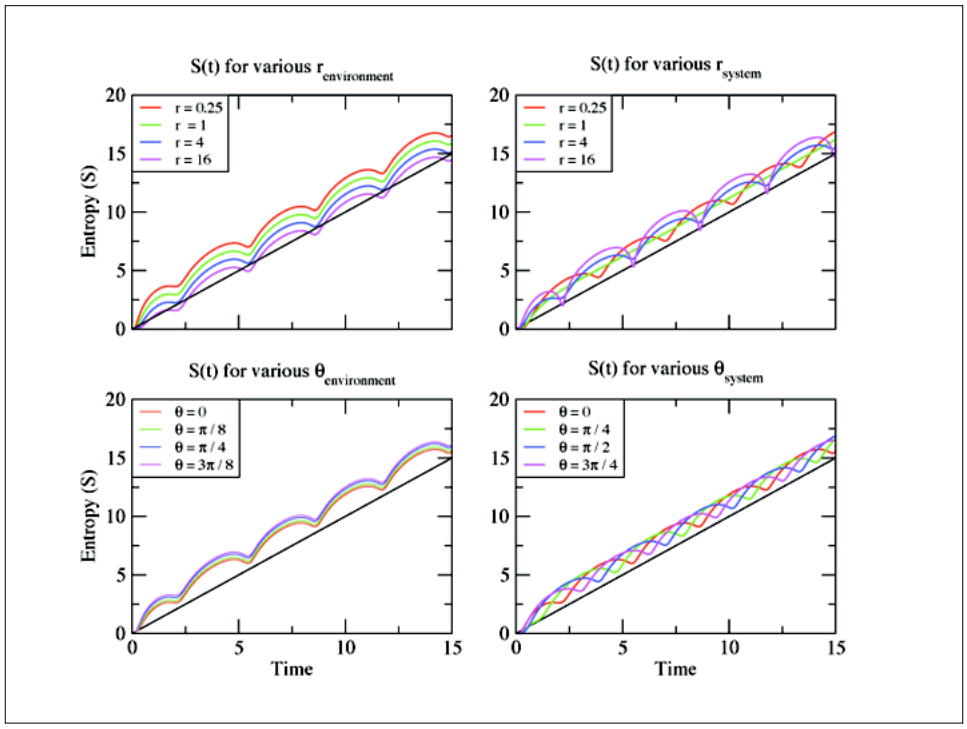

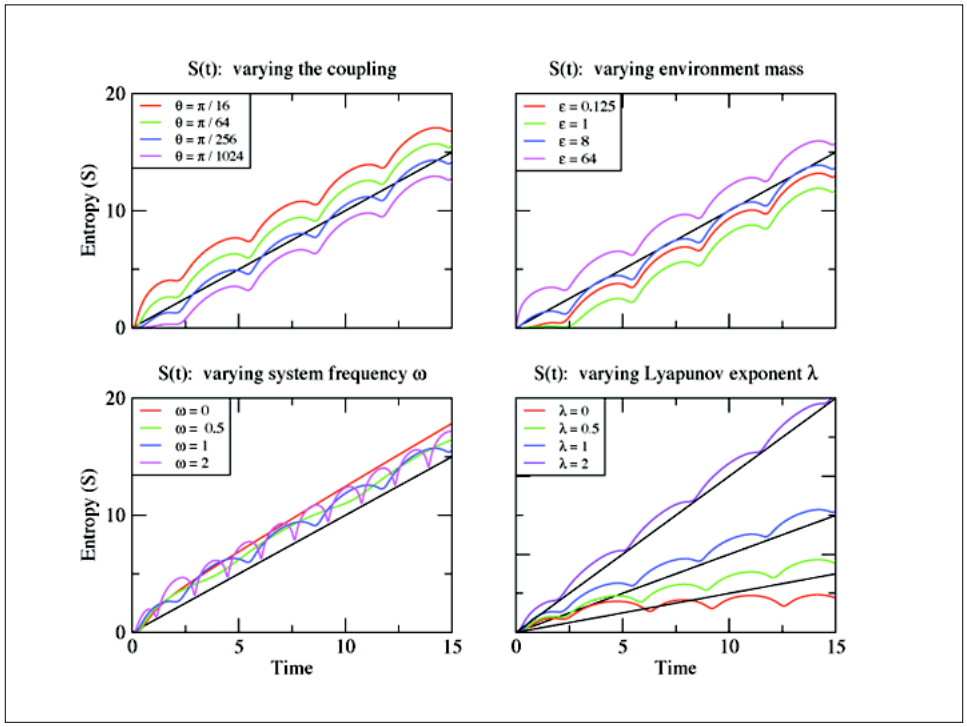

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Summary of Results and Conclusions

The inverted harmonic environment displays several expected features:

- The diffusion coefficients in the master equation increase exponentially with time.
- Entropy is produced as $S = \lambda t$.
- Entropy varies as the log of the coupling.

In addition, some strange or disturbing features require further study:

- The divergences in the master equation coefficients.
- How much entropy can be produced without seriously disturbing "classical" features?